EE 420 / ECG 620

Analog IC Design

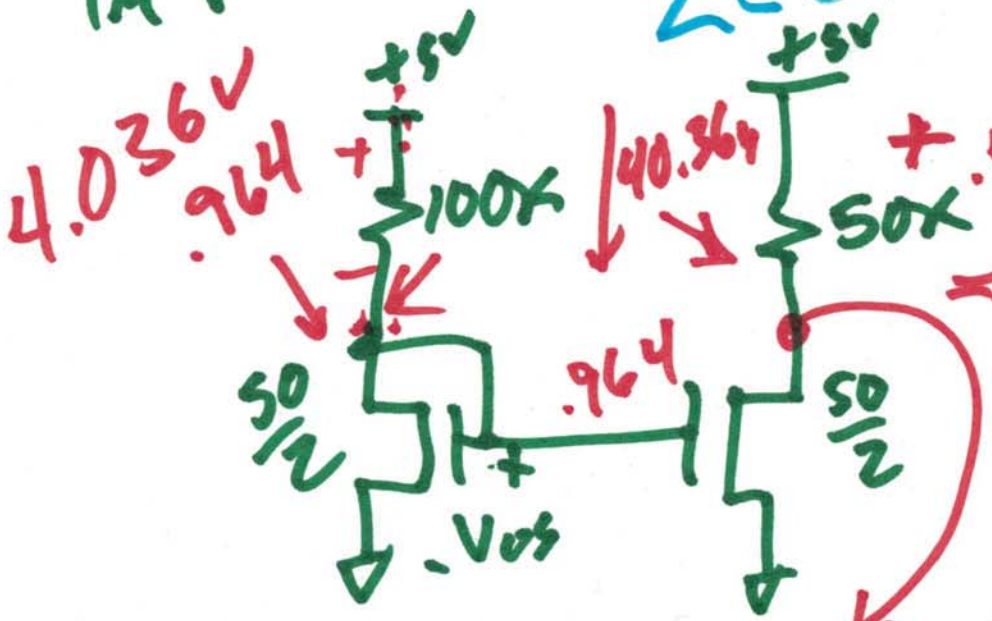
2/12/2016

Lecture 9

$K_{P_n} = 120\mu A/V^2$

$V_{TH_n} = 0.8$

1M Process



$$\frac{120\mu}{2}\cdot\frac{50}{2}\left(V_{GS}-0.8\right)^2 = \frac{5-V_{GS}}{100K}$$

$$5-40.36\cdot 50K = 4.518V$$

$$150\left(V_{GS}^2-1.6V_{GS}+0.64\right) = 5-V_{GS}$$

$$150V_{GS}^2 - 240V_{GS} + 96 = 5 - V_{GS}$$

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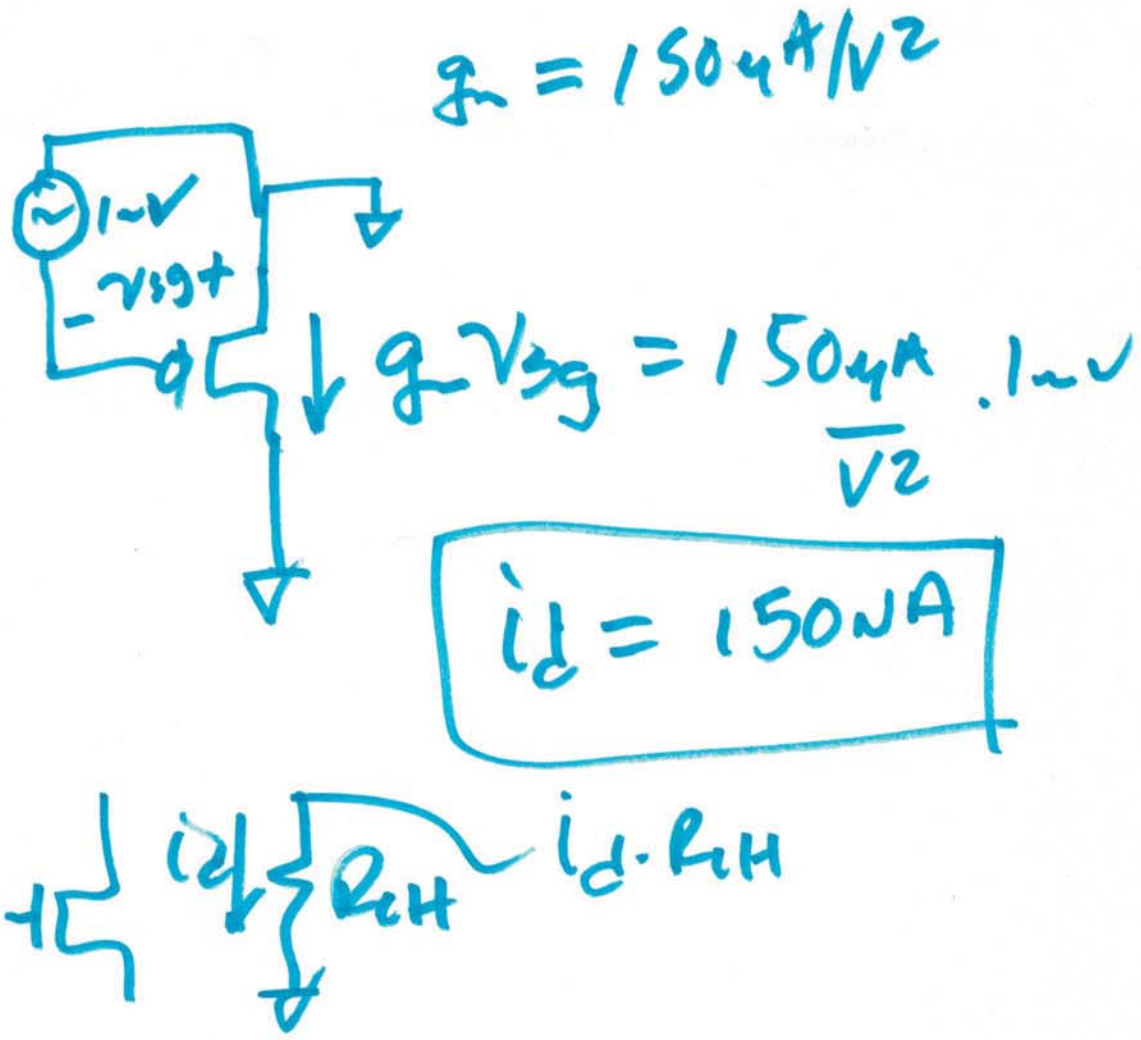
Quiz 5 EE 420/ECG 620 Analog, Spring 2016 Name: _____

Open book and closed notes.

Show your work for credit.

1. Work problem 9.13 on page 308 if the 1.3 V source is changed to 1.15 and the MOSFET is resized to 30/2. (4 points)



2)

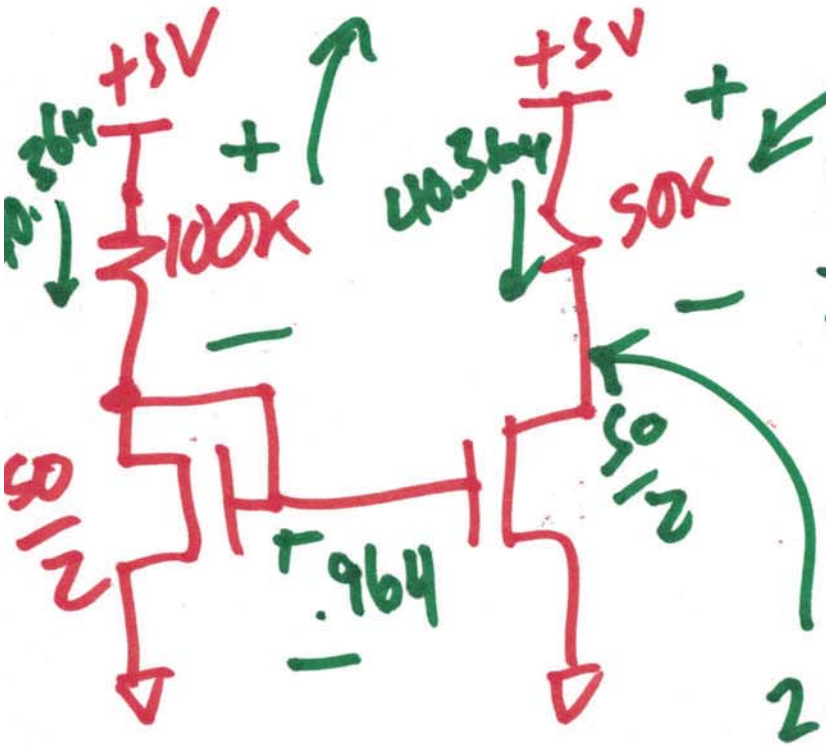
$$150V_{OS}^2 - 239V_{GS} + 91 = 0$$

$$V_{OS} = \frac{239 \pm \sqrt{239^2 - 4 \cdot 150 \cdot 91}}{300}$$

4.036V

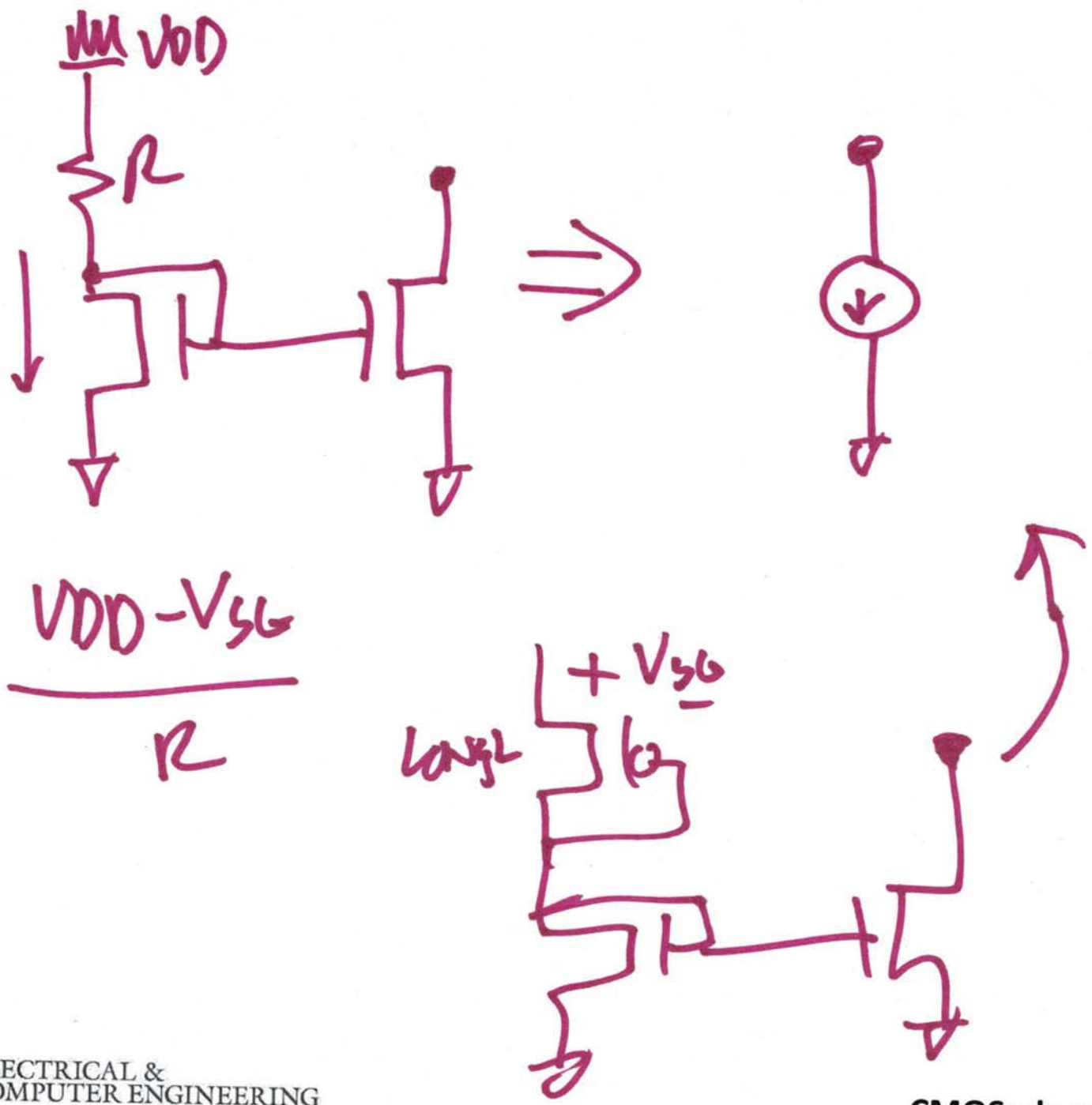
2.018V

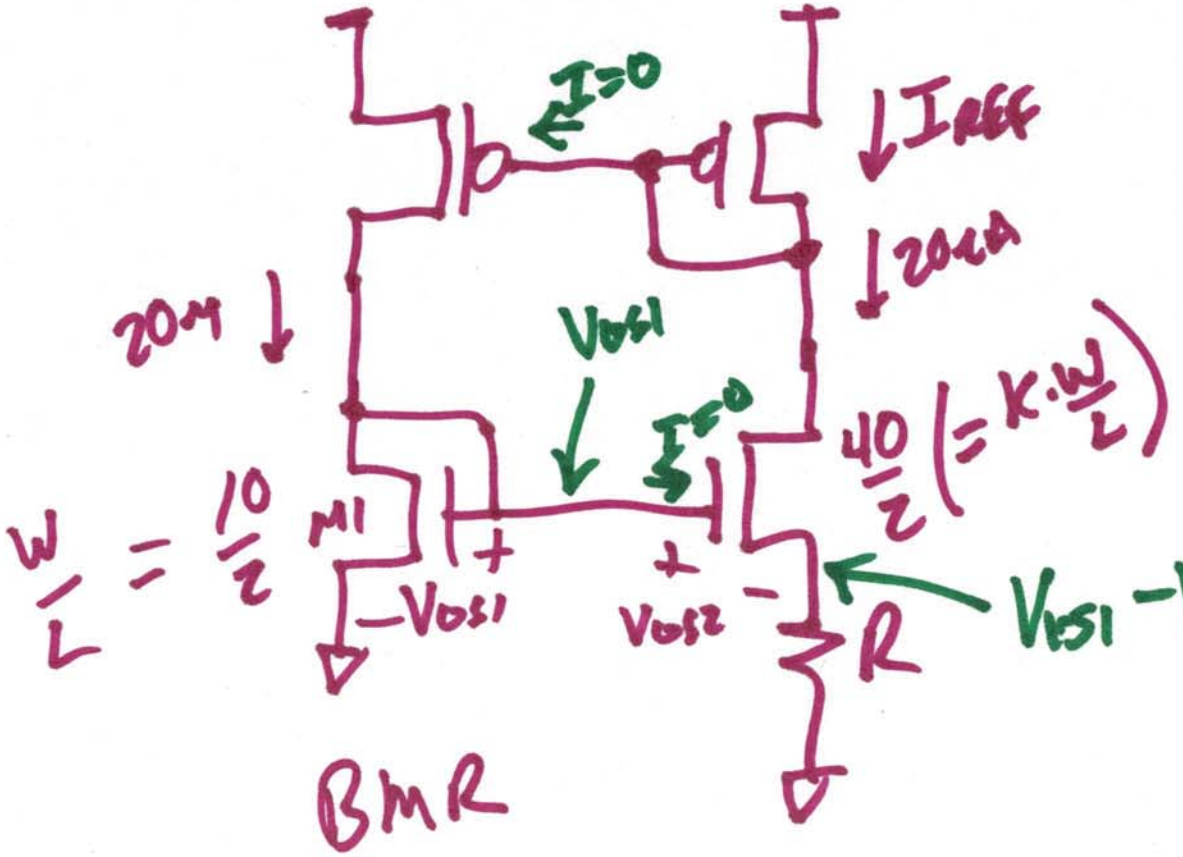
$V_{OS} = 0.964$ or $.0629$



$$I_D = \frac{5 - .964}{100K} = \frac{4.036}{100K}$$

$$= 40.36\mu A$$


VDD
R
$\frac{VDD - V_{SG}}{R}$
$+V_{SG}$



$$I_{REF} = \frac{V_{GS1} - V_{GS2}}{R}$$

$$I_{REF} = \frac{KP}{2}\frac{W}{L}\left(V_{GS1} - V_{THN}\right)^2$$

$$V_{GS1} = \sqrt{\frac{2I_{REF}}{KP \cdot W/L}} + V_{THN}$$

$$V_{GS2} = \sqrt{\frac{2I_{REF}}{KP \cdot K \cdot \frac{W}{L}}} + V_{THN}$$

$$\sqrt{I_{REF}} = \sqrt{\frac{2I_{REF}}{KP \cdot \frac{W}{L} R^2}} - \sqrt{\frac{2I_{REF}}{KP \cdot K \cdot \frac{W}{L} \cdot R^2}}$$

$$= \sqrt{\frac{2}{KP \cdot \frac{W}{L} \cdot R^2}} \left(1 - \sqrt{\frac{1}{K}}\right)$$

5)

$$I_{REF} = \frac{2}{KP \cdot \frac{W}{L} \cdot R^2}\left(1 - \sqrt{\frac{1}{K}}\right)^2$$

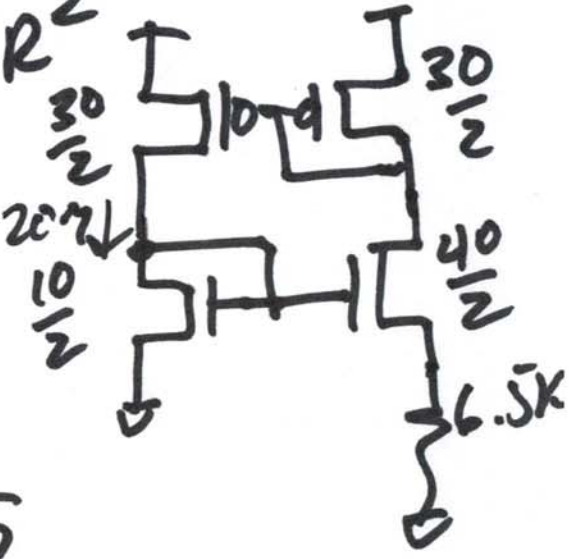
Let's say $K = 4$

$$I_{REF} = \frac{1}{2KP \cdot \frac{W}{L} R^2}$$

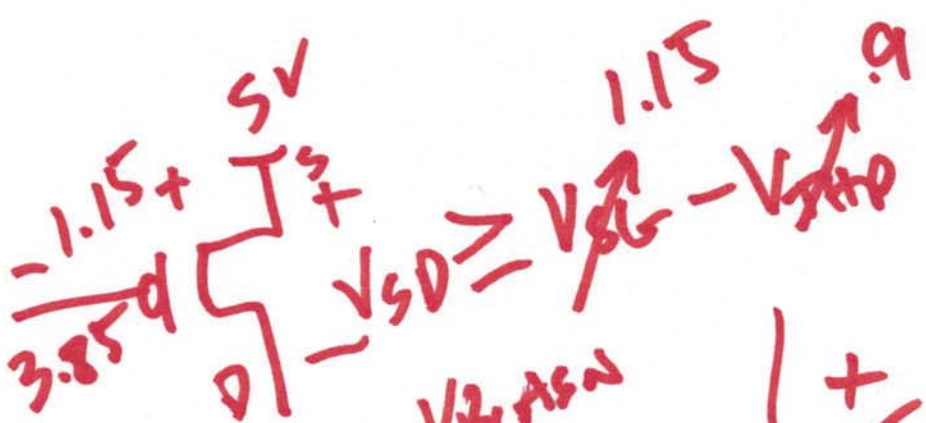
$$2KP \cdot \frac{W}{L} \cdot I_{REF} = \frac{1}{R^2}$$

$$g_m = \sqrt{2KP \cdot \frac{W}{L} \cdot I_{REF}} = \frac{1}{R}$$

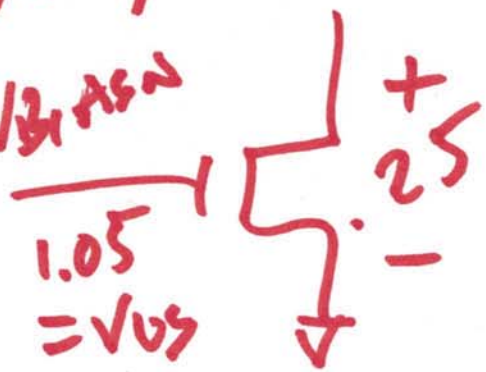
$= 150 \frac{\mu A}{V^2}$



Constant-g_m bias



$-V_{SD} \geq V_{SG} - V_{THP}$ (1.15, .9) $= 0.25 = V_{SD,SAT}$

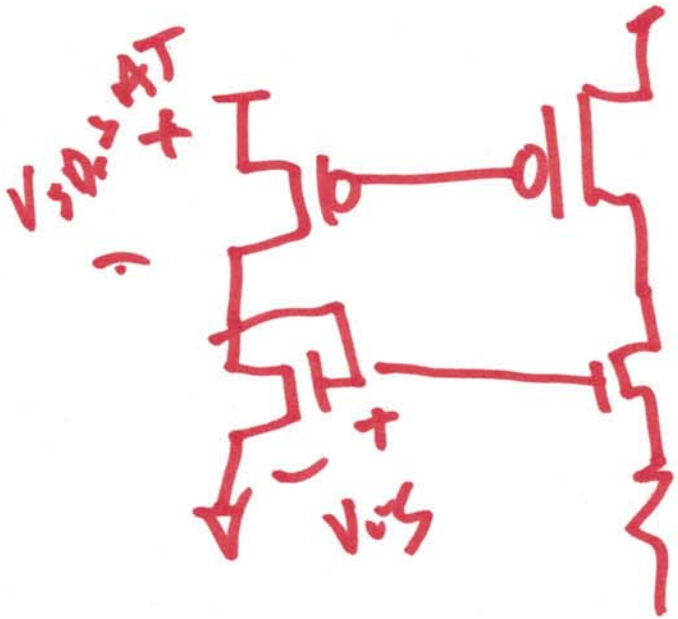


Saturation

$V_{DS} > V_{GS} - V_{THN}$ (1.05, .8)

$V_{DS,SAT}$

V_{OV}



$VDD > V_{GS} + V_{SD,SAT}$

$V_{OV} + V_{THN} + V_{SG} - V_{THP}$